Introduction

Self-Propelled Modular Transporters (SPMTs) consist of a load-carrying platform which is supported by multiple axle lines of independently steered wheel pairs (bogies), each capable of 360° of articulation, and each with its own hydraulic jacking system.

Multiple units can be linked together laterally or longitudinally to suite the project needs. Synchronized movement is achieved by connecting all units to a single control panel operated by one technician. Linking separate units to a single control panel is helpful for bridge projects because it allows SPMTs placed beneath the pick-points on opposite ends of the span to move in sync.

SPMTs have a manufacturer's stated capacity of 25,000 pounds per axle. The minimum available vertical stroke is 24 inches and the vertical lift range is between 36 and 60 inches.

The Manual for the Moving of Utah Bridges Using SPMTs (SPMT Manual) was developed by the Utah Department of Transportation (UDOT) to assist in the design and bidding of projects by providing a single reference source for specifications, codes, and recommended practices concerning the use of SPMTs to transport simply supported slab and beam spans, or "regular" bridges as defined by AASHTO. The SPMT manual offers guidance to:

- **UDOT**
- **Contractors**
- **Engineer of Record (EOR)**
- **Resident Engineers**

The Contractor may fulfill certain responsibilities by delegating them to sub-contracted engineers. This manual also provides guidance for the Contractor's:

- **Bridge Specialty Engineer (BSE)**
- **Heavy Lift Engineer (HL)**

The following sections include a general overview of the responsibilities of each entity throughout all stages of the project. Each section includes a sample checklist that will be modified for each project to suit site specific conditions. The sections written to the EOR describe the necessary information to be investigated and included in the contract documents. The sections written to the Contractor provide information necessary to bid on SPMT projects.

This manual is written following a Design Bid Build (DBB) contracting model. Special provisions are included for Design Build (DB) and Construction Manager/General Contractor (CMGC) projects.

Description of Equipment

This manual contains standards for moving bridges using SPMTs. These standards apply to SPMTs defined by the following characteristics:

- A load-carrying platform
- Multiple axle lines of independently steered pairs of wheels
- A 360˚ turning capacity for each axle
- An independent hydraulic jacking system for each axle
- A lifting capacity of 25,000 pounds per axle
- A minimum available vertical stroke of 24 inches
- A vertical lift range is between 36 and 60 inches

SPMT units vary according to the number of axle lines they possess, and the number of wheels per axle line. Dimensions of the various SPMT units are shown in Table 1:

SPMT Unit Dimensions	Weight	Length	Width	Elevation
4-Axle Units				
4 wheels per axle		20 Feet	8 Feet	
8 wheels per axle		20 Feet	10 Feet	
6-Axle Units				
4 wheels per axle		30 Feet	8 Feet	
8wheels per axle		30 Feet	10 Feet	
Power Pack				

For scale drawing of SPMT units refer to 2007 FHWA Manual or manufacturer/vendor documents.

Computerized electronic steering allows movement in any direction: forward and backward, transversely, diagonally, at any angle, and carousel steering. SPMTs typically carry loads at walking speed (approximately 3 mph), but have a maximum speed of 7 mph. They have been used to carry bridges over grades up to 6 percent.

SPMTs can be linked longitudinally or laterally to achieve the number and configuration of axle lines required by the load. Linked units can be synchronized to a central computer. The controller has four basic commands: steer, lift, drive and brake.

Refer to the FHWA 2007 Manual Section 1.2 and Appendix D for further details.

Cost-Benefit Analysis

SPMTs can aid bridge replacement in two ways. They can remove the existing bridge, eliminating the need for on-site demolition, and they can transport an entire prefabricated span from the Bridge Staging Area (BSA) to the final bridge site. This process limits the interruption of service for a bridge replacement to days or hours by eliminating the need for on-site construction. Replacing bridges with SPMTs offers additional benefits such as increased worker and traffic safety, improved construction, and improved durability.

The characteristics of projects ideal for installation by SPMT methods are projects that require minimal closure time, and projects which offer available locations for offsite bridge construction as well as a feasible route for transporting the bridge from the staging area to the installation site.

A project may require minimal closure time if:

- The bridge or underneath roadway has high traffic volumes
- The bridge or underneath roadway is on an emergency evacuation route
- The bridge is over a railroad or navigable waterway
- Schools or hospitals are accessed via the bridge or underneath roadway
- Overhead or adjacent work space constraints such as power lines or hurricane barriears prevent the use of conventional construction with cranes
- Air or noise quality constraints limit the type or timing of construction activities
- Endangered species on the site limit the timeline for construction activities
- Weather constraints such as cold weather limit the length of time for construction activities

Benefits

The use of SPMTs allows bridges to be prefabricated away from their final location and moved into place when they are complete. The installation process is reduced to hours, as opposed to months for conventional construction. Rapid installation benefits bridge replacement projects to two primary ways:

1) It reduces the interruption to the traveling public
2) It reduces the time workers and traffic are exposed to one another

There are additional benefits related to prefabricated construction methods including:

1) Longer cure times for all concrete components
2) Control over the environment at the construction site
3) Lower life-cycle costs
4) Fewer deck joints
5) Less material required

Costs

SPMT projects carry high initial costs due to the base rate of renting SPMT equipment. Associated with the base rate are the mobilization times, which are usually 3 days prior to operation and 3 days after operation. The amount of effort the Heavy Lifter (HL) must put into engineering also increases the cost of a project. Additional engineering requirements such as site preparation at the Bridge Staging Area, Travel Path, and Final Bridge Location, and the risk-associated costs of innovation are all contributing factors. To determine if these initial costs are outweighed by the reduced project impact and improved construction values, follow UDOT ABC decision tree. For additional guidance in selecting SPMT projects refer to FHWA PBES Decision Making Framework.

Contracting Methods

The body of this manual is written assuming a Design-Bid-Build contract scheme (DBB), however, Construction Manager/General Contractor (CMGC) and Design Build (DB) methods shift liabilities and responsibilities in a way that can be advantageous to the project.
CMGC and DB are methods of pairing the Contractor and the Engineer of Record (EOR). In both cases the EOR works for the Contractor. As a result there is a greater incentive for value engineering in the initial design, which in turnleads to lower cost and fewer change orders. This can expedite the design process and allow for construction to begin while design is ongoing. CM/GC or DB can benefit projects where movement is likely to be complex and require flexibility in the engineering of the BSA, TP and SPMT configuration and temporary works.

Cost Anticipating Guide

I suggest including a guide for anticipating cost of using SPMTs. This would include a list of bid items and how they drive this cost, as well as other wisdom.

The purpose of this section would be to help UDOT leadership evaluate the quality of bids it is receiving. It will ensure that UDOT selects and advertises projects in a way that will clearly state expectations, assign liabilities, and indicate risks so that bidders are not deterred from bidding or overbidding to offset the risks of this innovative process.

Accurate estimating so bids come in near our estimate.

Suggested bid items:
Permanent bridge structures (superstructure, piers, abutments, bents, approach slabs, etc)
Temporary bridge structures (temp. works at BSA)
Lifting devices (SPMTs, jacks, SPMT supports, cranes, etc.)
Site prep (BSA and TP can require many specific, costly preparations so I think this could be a good bid item. Square footage of site prep, different payout for grading, leveling, paving, replacing soft soils (cubic), etc.)
Utility protection (square footage and type of utility protection?)

Deflection monitoring

UDOT and Utilities

UDOT must decide how it will address utilities. Will UDOT guarantee to pay for damage to utilities or allow contractors to take that risk and bid accordingly? Also, what leverage does UDOT have with utility companies?

UDOT and BSA and TP

Consensus at the breakout group, 11/5/08, was that UDOT should select projects which have a suitable BSA and TP. This was for DBB, I think. In the other methods it is up to the contractor/designer to chose installation method, and thus provide BSA and TP if choosing to use SPMTs. Right?

Engineer of Record

In This Section

Overview

The Engineer of Record (EOR) designs the permanent structure meeting the most recent UDOT, AASHTO, and local code requirements for in-service condition.

The EOR coordinates the work of various other engineering disciplines by providing design assumptions and reviewing drawings necessary to the project. Related engineering disciplines include:

- Geotechnical
- Electrical
- Mechanical
- Structural
- Highway
- Traffic

The EOR provides designs satisfying required standards and quality for the project. All designs are stamped by a registered engineer in the state of Utah.

SPMT-Specific Assurances

The EOR provides the following additional assurances:

- Structural design meeting code for in-service condition
- Structural design capable of tolerating lift and transport
- Substructure design
- Proper axle-load estimates for lifting device
- Ground-bearing capacity of Bridge Staging Area (BSA) and Travel Path (TP)
- Maximum expected and allowable deflection and twist during lift and transport

Utilities and Right-of-Way

EOR identifies vulnerable utilities
EOR identifies right-of-way requirements

EOR Synopsis

The Engineer of Record is an engineer licensed to practice in the State of Utah. The EOR provides designs for the superstructure and the permanent substructure meeting all UDOT, AASHTO, and local code requirements. When designing the superstructure the following *three* basic assumptions are required:

1) That the built in place substructures are constructed within tolerances of the superstructure and provide adequate clearance for the superstructure.
2) The pick-points are as-planned.
3) This document pertains to the movement of simply supported beam and slab spans.

With these assumptions, the EOR can provide the information necessary to coordinate the other engineering disciplines that are required for SPMT projects. The various disciplines, the information they require, and their coordination with the EOR are as follows:

Temporary Structures Engineering

The EOR states on the project plans the minimum required submittals for approval to proceed with construction and transportation of the new superstructure. Refer to the Submittals section of the Contractor chapter for a sample listing of submittal items.

The EOR coordinates the design of temporary supports by providing the Contractor with an accurate calculation of the bridge weight, the dimensions of the permanent supports, the dimensions of the superstructure, the geometric tolerances of the superstructure, anticipated deflections, and the impact factor for temporary stresses. It is the Contractor's responsibility to provide engineering for temporary structures including the temporary supports at the BSA, upon the SPMTs, and at the final bridge location if any jacking towers or other lift systems are required to bring the bridge to its final elevation.

An accurate calculation of the weight of the superstructure influences the type of temporary abutments needed, and the measures that must be taken to counteract settlement beneath the temporary abutments. The dimensions of the superstructure and its permanent supports provide guidelines for the profile of the temporary abutments (what about piers?). The geometric tolerances indicate what (if any) permissible deviation there is from the permanent support conditions. Using this information, the Contractor provides PE Stamped working drawings for the temporary abutments which the EOR reviews. See submittals in contractor section. Construction of the temporary abutments does not begin until the EOR approves the drawings. (*Site spec on reviews?*) EOR verifies that the proposed temporary abutments will meet AASHTO LRFD Guide Design for Bridge Temporary Works and the specific requirements of the project.

The design of the SPMT Supports is influenced by the total weight of the bridge, the pick-point locations, the impact factor for temporary stresses, and the configuration of the SPMTs. The EOR coordinates the design of the SPMT supports by reviewing the Contractor's PE-Stamped drawing to verify that they provide adequate support for the total superstructure plus the impact factor (determined by the EOR) for lifting, transport, and setting. Due to equipment constraints or value engineering the Contractor may not

accept the designed-for pick points. When reviewing the design of the SPMT supports the EOR verifies that the pick-points are acceptable before granting approval. The EOR also examines the SPMT support design to ensure that equal support is provided to all beams.

The design of the jacking towers or other lifting mechanisms at the final bridge location is also affected by the total weight of the superstructure and its impact factor. The EOR reviews the Contractor's PE-Stamped designs to ensure that equal support is provided to all beams. The EOR also confirms that the lifting systems are adequate to support the total weight of the structure and resist settlement before authorizing the plans.

Geotechnical Engineering

Geotechnical engineering is conducted in two phases on SPMT projects. The first phase is a preliminary assessment of geotechnical considerations at prospective BSAs, along prospective TPs, and at the final bridge location. The second phase is a detailed assessment of the final BSA, TP, and final bridge location which includes mitigation of any ground bearing capacity, slope stability, or underground utility constraints.

The EOR conducts the preliminary geotechnical investigation. The purpose of this investigation is to locate areas of concern and determine whether it suits to project better to avoid these areas or develop mitigation for them. The geotechnical issues may be difficult to assess, or the mitigation factors may add to the complexity of the project and could require the expertise of a specialized geotechnical engineer. "If the EOR believes a geotechnical engineer is required based on the subsurface exploration performed during the design process, this should be outlined in the RFQ" (Bryan Busch).

Any final geotechnical assessments of the BSA, TP, and final bridge location required in the RFQ are provided by the Contractor. The EOR coordinates the geotechnical engineering by provided accurate calculations of the total bridge weight, and by verifying that the axle loads are accurate, as the number of axle lines in the original plans may differ from the number actually in use. The EOR also verifies that the settlement estimates and mitigation plans are adequate for all areas of influence.

Mechanical Engineering

The mechanical engineering aspect of the project involves determining the mechanical requirements of the project, and accommodating the capabilities of the machinery. During the design phase the EOR consults with HLs to determine the required number and configurations of the SPMT units. These factors will be influenced by the total weight of the structure, a 10% contingency factor for out-of-service axles, and constraints at the BSA and final bridge site which limit the SPMTs' access. This is critical in designing for the pick points. The ideal pick point locations are as close to the ends of the span as possible, yet the SPMTs require sufficient clearance from the temporary abutments and the side walls at the final bridge location. Collaboration is required to identify the best possible combination of pick-point location and SPMT system configuration.

The as-built configuration of the SPMT system may differ from the as-planned configuration. The actual availability of SPMT units may be fewer than the plans require, or the Contractor's elector SPMT system may not be capable of lifting the bridge at the as-designed pick-points. The EOR reviews any such changes provided by the Contractor in the form of PE-stamped drawings and, when appropriate, authorizes the re-design.

Roadway Engineering

The EOR verifies that the design suits the profile and needs of the roadway the bridge resides along.

Traffic Control Engineering

The EOR verifies that the traffic control plan for all phases of the project is suitable for all operations.

Electrical Engineering

Aesthetic Engineering

Refer to UDOT Bridge Aesthetics Policy, and UDOT 2009 Design Network 15Y.

Public Involvement

Rapid bridge replacement projects attract a great deal of public interest and can lead to positive public image for all parties involved. Keeping the public informed can enhance this opportunity and reduce the impact of unexpected delays to the project.

Utilities and Right-of-Way

The two leading factors which contribute to disputes with utility companies are:

1) A poor understanding of the risk associated with crossing underground utility lines with SPMTs.
2) Uncertainty over which party is liable if there is damage to a utility.

Early communication with the utility can eliminate misunderstandings and help lead to a practical solution without any delays to the process.
Refer to attached flowchart for the process of obtaining written sign-off from utilities.

EOR Checklist page 1/2

Project Number Date

#	Initial	Date	
1			Identify and investigate final bridge location, possible bridge staging area (BSA), and Travel Path (TP). (DB Provision to be added later)
2			Select bridge type and transport configurations.
3			Design BSA and TP
A			Identify modifications along TP
B			Written sign-off on utilities
C			Investigate clearance
D			Perform load rating of bridges along proposed TP
4			Draft Situation and Layout (S&L) for final bridge location
A			Clearance
B			Geotech, utilities, etc.
C			Identify components built in place
D			Identify components built elsewhere and moved into place
E			Identify pick-points
1			Compile list of HLs
2			Consult Heavy Lifters (HLs) to design bridge with pick-points
5			Review total plan package
6			Industry review

EOR Checklist page 2/2

7				Final design
	A			S&L of permanent structures
	B			S&L of BSA and TP
	C			S&L for removal or demolition of structure to be replaced
8				Attend plan review meeting with UDOT and entire design team
9				Finalize Plan
	A			Develop criteria for temporary supports
	B			Develop criteria for deflection, twist, etc.
	C			Write specs
	D			Stamp designs
10				Develop monitoring plan
11				Develop cost estimates for temporary abutments
12				Prebid meeting
13				Review shop drawings
14				Provide construction support
15				Field walk though. Total package reviewed before old bridge is removed.
16				Final assessment

EOR Checklist Description

1. **Identify and investigate final bridge location, possible bridge staging area (BSA), and Travel Path (TP)**

A. Identify clearance, utility, geotechnical and other constraints at the final bridge location.

B. Selection criteria for prospective BSA and TP include but are not limited to:

1. Ample space for all construction activities
   The BSA requires space to build the entire structure upon temporary abutments.
2. Proximity to permanent location
   SPMTs have carried bridges over distances as great as 1.5 miles, and over slopes as steep as 6 percent. The TP between the BSA and the permanent bridge site requires extensive investigation and/or preparation to deal with the SPMT's tolerances for grade, and the potential traffic impact as the SPMT proceeds along the TP.
3. Geotechnical considerations
   Assess potential BSAs and TPs to identify issues regarding slope stability and ground-bearing capacity appear upon preliminary inspection. Consider the areas of influence beneath the SPMTs, the SPMT support apparatus, the bridge superstructure at the lift location, and the loaded SPMT along the TP.
4. Utilities
   Inspect potential BSAs and TPs to locate above and below-ground utilities. Identify the utility owner and obtain the type, size, location, and depth of any buried utility lines.
5. Site restrictions
   Consider the impact to the project of any local restrictions such as site protection, noise restrictions, structures and roadways driven over, etc.
6. Final bridge location
   Identify and investigate geotech issues at the installation site. This includes areas of influence beneath the loaded SPMTs, jacking towers, carrier beam towers, various other support structures, and the permanent foundation.
7. TP accessibility
   Verify that proposed BSA provides suitable access to the TP.

2. **Bridge type selection**

Determine the type of structure and identify its approximate dimensions and weight. Include the weight and dimensions of the lifting system during lift and transport.

3. **Design BSA and TP**

Design BSA and TP after conducting thorough investigation of geotechnical, fit, and accessibility issues. Provide stamped S&L, and necessary permits for each of the following:

A. Design of mitigation for ground-bearing capacity at area of influence beneath wheels along the entire length of the TP. Anticipate variations in the load distribution between individual wheels. Account for vertical slope, cross slope, "soft" soils, and areas where the SPMT makes a sharp turn. Provide slope stability assurances for all slopes near any segment of the TP.

B. Obtain written sign-off from utility owners:
"Locate all utilities that may be impacted during the project" both at the BSA and along the TP (Hugh's comments). "Confirm depth, size, location," and type of utility (Mike Arnes' and Hugh's comments). "Meet with utility owners, discuss loads" (MA and H comments). Load limits over utilities vary depending upon how long the load is applied. Consult utility owners to determine bearing capacity for utilities driven over versus parked upon.
Obtain written "sign-off from utility owners," confirming permission to drive over utilities and establishing agreed-upon limits for planned or emergency parking over utilities. (MA and H comments).
Determine the hierarchy within the utility in question. Different groups within the utilities can and have overridden written permission on SPMT projects. Confirm that written agreements come from the highest necessary jurisdiction within the utility.

C. Design of mitigation for above-ground obstructions such as signs, trees, power lines and poles, light poles, buildings, etc. Ensure there is adequate vertical and horizontal clearance for structure and SMPTs.

D. Perform load rating of bridges along proposed TP:
Obtain bridge owners permission to cross any bridges along travel path. Verify that the total weight of SPMTs, SPMT supports, and the bridge superstructure can be sustained by existing bridges to be crossed. manufacturers estimate an operating capacity of 33 tons per axle line, however, designers prefer to stay within the 20-25 ton range with a 10 percent contingency for out of service axles. Specify the number of axle lines to stay below the load limits of any bridges to be crossed.

4. Draft S&L for final bridge location

Draft S&L for final bridge location indicating:

A. Plans for site preparation to accommodate the TP of the SPMT (Nickus 27). This may include mitigation of any clearance issues and fit issues between the structure to be installed and the permanent abutments. It may also include plans for raising the bridge to setting height such as jacking, building ramps up to the permanent abutments, etc.

B. Plans for mitigating geotechnical and utility issues. The amount of time that the SPMT will be parked in final position and engaged in precision maneuvers can be difficult to estimate and there may be time-sensitive issues regarding the applied load.

C. Identify components built in place.
D. Identify components built elsewhere and moved into place
E. Identify pick-points

The ideal pick-points would be at the ends of the span, however this is not possible, therefore it is best to pick the bridge as near to the end of the span as possible. Increasing the cantilever overhangs and closing the distance between the pick points will decrease stability and increase the dynamic response of the structure The locations of the pick-points affect the configuration of the SPMT systems because the SPMTs require adequate clearance from the temporary and permanent abutments, and the nearer to the end of the span that the pick-points are the less clearance the SPMTs will have.

1. Consult with Heavy Lifters (HLs) because ideal pick-points for the structure may not conform to the conditions at the BSA, or the mobility of the SPMTs.

2. The following list of North American HL companies possessing SPMTs with the capabilities defined in this manual was current as of 10/13/08:

Sarens?

Barnhart Crane and Rigging Co.
1701 Dunn Avenue
Memphis, Tennessee
38106
901-775-3000
800-727-0149
901-775-2992 fax
sales@barnhartcrane.com
www.barnhartcrane.com
Jeff Latture, Sr. Vice President - Sales & Marketing
Will Smith, Heavy Civil Sales
251-654-0541(O)
251-422-0701(Cell)

Bigge Crane and Rigging Co.
10700 Bigge Avenue
PO Box 1657
San Leandro, CA 94577
510-638-8100
510-639-4053 fax
jnelms@bigge.com
www.bigge.com
www.biggeequipment.com
Joe Nelms, V.P. Sales & Marketing

Fagioli, Inc.
8434 Brookside Road
Pearland, Texas 77581
281-997-3434
713-819-1460 cell
281-997-9848 fax
s.depaoli@fagioli.com
www.fagioli.com
Stefano De Paoli, Engineering and Operational Manager

Mammoet USA
20525 Farm Road 521
Houston, Texas 77583
281-369-2200
281-369-2178 fax
Bill.halsband@mammoet.com

3. Prior to designing TP, Obtain HL's performance spec (aka "operational envelope") and a list of references to confirm the

SPMTs are capable of performing the maneuvers detailed in the plans and according to the planned pick-points.

5. Review total plan package

See Review Process figure.

6. Industry review

Solicit input from the contracting community:

An industry review allows contractors (and possibly lifters and designers) to review the project plans and offer recommendations concerning the BSA, TP, global constructability, maintenance of traffic, etc. Contractors may be able to provide alternative locations for staging areas, or cost-saving alternatives to the limits of operations. (Paul Blackham conversation 10/13/08).

7. Final Design

Electronically submit project design for review. (Where should they send it, and in what format?) Include S&L for:

A. All permanent structures
   1. Bridge superstructure
   2. Permanent substructure

B. BSA and TP. Include any commitments made in clearing the TP on the plan set, or within the limitations of operations.

C. Removal or demolition of structure being replaced

   Provide plans for the removal of the existing bridge. The existing bridge may be demolished in place, or removed using SPMTs and demolished elsewhere. Provide S&L for TP between bridge site and demolition site, and S&L for demolition site taking into account all constraints at the demolition area.

8. Attend review meeting with UDOT and entire design team

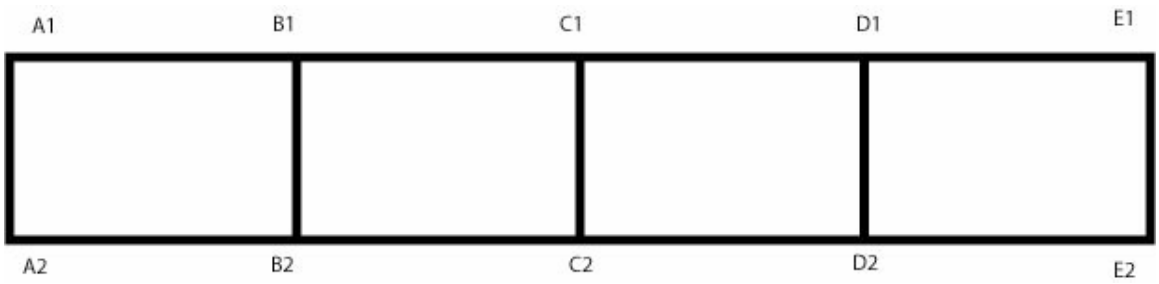
Review project plan with UDOT Deputy Bridge Engineer, and other engineers such as; geotechnical, electrical, mechanical, structural, roadway, traffic control. Also involve Right-of-Way and Public Involvement officials.

9. Finalize Plan

A. Develop criteria for temporary supports
   1. The 2 basic criteria for bridge temporary works are to:
      a. Meet code for the AASHTO *Guide Design for Bridge Temporary Works* and the AASHTO 1995*Construction Handbook for Bridge Temporary Works.*
      b. Provide sufficient clearance for the SPMTs and SPMT superstructure to pass beneath them.
   2. Specify the clearance and load requirements to meet these criteria for the designed superstructure.

B. Develop criteria for deflection, twist, etc.
   1. Deflection

      Provide anticipated deflections for the following points along the span:



Where “A” and “E” represent the ends, “B” and “D” represent the pick-points, and “C” represents the center line.

Quantify the anticipated deflections at each point and at each of the following time intervals (these figures will also serve as the anticipated stroke needed to raise the bridge off of its supports):

Time	Condition		A	B	C	D	E
T1	Under the self weight of (and prestress) of the beams when spanning the temporary supports in the BSA	1					
		2					
T2	Under the weight of cat-in-place diaphragms and formwork when spanning the temporary supports	1					
		2					
T3	Under the initial (wet) weight of cast-in-place deck slab and build-up concrete when spanning temporary supports	1					
		2					
T4	Under hardened slab conditions after removing forms and adding superimposed dead loads from barriers, parapets, medians,etc, immediately before lifting	1					
		2					
T5	Under all structural and superimposed dead loads when the structure is lifted by the SPMT	1					
		2					
T6	In the final condition in-place in the structure (expected to be the same as the “before lift” condition	1					
		2					
T7	For all the above, for precast prestressed or post-tensioned beams, take into account the age of the concrete at the time of the operation	1					
		2					

Nickas 34

2. Twist

Provide the allowable Maximum Twist in terms of the amount (in decimal feet) that one corner of the span may deflect up or down relative to the plane defined by the other three corners. Provide this for two separate locations as follows:

i. Locations A1, A2, E1, E2 (bearings) - in this case, the corners for checking twist are points located on the deck surface above the center of each edge beam at the centerline of the temporary (and permanent) support bearings.

ii. Location B1, B2, D1, D2 (SPMT Supports) - in this case, the corners for checking twist are points located on the deck surface above the centerline of each edge beam at the centerlines of supports of the SPMT support system.

3. Crack criteria

Develop crack criteria (consult Larry R on his crack mapping activities)

C. Write specs to contractor for all project requirements

D. Provide all final S&L stamped by a registered engineer in the State of Utah

10. Develop monitoring plan

A. Geometric monitoring is most critical during lifting and setting. Provide a plan detailing the "measuring equipment, procedures and locations of geometry control reference points on the superstructure, in the staging area and at the bridge site" (Nickus 69). Include:

1. The location and values of permanent benchmarks and reference points in the staging area and at the bridge site.
2. Deflection profiles of prefabricated steel or concrete girders under their own self weight, under the additional weight of the cast-in-place concrete and forms (see below #14).
3. Long-term deflections, under the effects of creep and shrinkage, along with appropriate cambers proposed for construction at the staging area and anticipated long-term behavior after setting at the site.
4. A geometry control procedure for monitoring the distortion (twist) and relative deflections at support locations, of the as-constructed concrete surface of each span.
5. Lateral and longitudinal location reference points on the prefabricated superstructure that correspond to, or can be referenced to appropriate lateral and longitudinal location reference points at the erection site.
6. Verification of the experience and qualifications of supervisory and survey instrument operating personnel, particularly with regard to observational precision required.

B. During the move it may be difficult to triangulate the position of reference points, in which case excessive deflections can be identified with real-time instrumentation or visual inspection of the girders and diaphragms.

11. Pre-bid meeting

Attend pre-bid meeting

12. **Develop cost estimates for temporary abutments**
    Generally, UDOT pays these items by the pound of steel and cubic feet of concrete.
13. **Review shop drawings**
    Confirm that Contractor-provided shop drawings for BSA and TP, temporary abutments, SPTM lifting apparatus and pick-points, etc, conform to original design. If Contractor's shop drawings are not as-designed, review alternative designs provided by Contractor. The EOR may take up to 5 days to review new drawings each time they are submitted without awarding any additional time for construction.
14. **Provide construction support**
    Depending on the contracting method, UDOT or the contractor retains EOR to review change orders, check contract compliance, and provide additional design support.
15. **Field walk though. Total package reviewed before old bridge is removed.**
16. **Final assessment**

Engineer Of Record's

Geotechnical Engineer

In This Section

Overview
The EOR provides geotechnical PE-stamped Situation and Layout (SL) for the BSA, TP, and final bridge location. This included the areas of influence beneath the SPMTs during all phases of lift, transport, and setting, and beneath the permanent foundation.

Assumptions

The EOR designs SL using certain assumptions, including the total weight of the bridge and the SPMT movement system, the wheel loads, and the configuration of the SPMT movement system.

The EOR investigates potential BSA and TP to determine if the ground at those locations could feasibly support the assumed forces. When a suitable BSA and TP have been chosen the EOR calculates ground capacities, investigates utilities, and designs mitigation.

Specific concerns at the BSA include:

Capacity of ground in entire BSA to support assumed forces
Vulnerable utilities
Access points for SPMTs entering and leaving BSA
Jacking towers

Specific concerns along TP include:

Capacity of ground at areas of influence beneath wheel lines along entire TP
Utilities crossed
Areas where SPMTs perform turns
Nearby slopes
SPMT access points at final bridge location
Jacking towers

Because the EOR does not design the temporary abutments the Contractor provides geotechnical calculations and designs for the foundations of the temporary abutments.

EOR's Geotech Checklist

Project Number Date

#		Initial	Date	
1				Conduct preliminary survey of prospective Bridge Staging Areas (BSAs), and Travel Paths (TPs).
2				Conduct geotechnical investigation at final bridge location.
3				Finalize geotechnical report at final bridge location and complete design of final foundation
4				Conduct investigation of the following
	A			BSA
	B			Jacking towers
	C			TP
5				Design mitigation for soft soils, vulnerable slopes, and vulnerable utilities.

EOR's Geotech Checklist Description

1. Identify issues regarding ground bearing capacity, slope stability, and underground utilities. For preliminary investigation, assume SPMTs exert a maximum force of 2,000 pounds per square foot (FHWA).

2. Conduct a thorough survey of the final bridge site by taking borings, or other soil samples, and conducting necessary monitoring of ground conditions to provide a complete assessment of the geotechnical profile.

3. Provide PE-stamped settlement calculations for permanent foundation. Specify appropriate materials and design for permanent foundation.

4. Investigate ground conditions at:

- **A.** BSA: Provide soil deflection estimates for the area of influence beneath the SPMT systems before, during, and after the span has been lifted from the temporary abutments.
- **B.** Jacking Towers: If jacking towers are used to lift span to setting height, provide soil deflection estimates for area of influence beneath jacking towers.
- **C.** TP: Provide soil deflection estimates for the area of influence beneath the wheel lines of the SPMTs. Special allowances are required for locations where the SPMT makes a sharp turn. Include a fractional contingency for out-of-service axles.

5. Design mitigation for any areas where the ground is insufficient to resist the forces exerted by the SPMTs, the span, and any supports. Such mitigation may involve spreader beams or steel plates, soil compaction, replacement of soft soils, pavement, etc. Confirm the size, depth, type, and location of any utilities at BSA, along TP, or at the final bridge site. Develop mitigation to alleviate forces acting upon any utilities to be driven over or parked upon. Develop contingencies for any emergency stopping over vulnerable utilities.

Contractor

Overview

The Contractor provides all services related to:

- Demolition/removal of old span
- Construction of new span
- Construction of permanent substructure
- Construction of temporary substructures
- Transportation of new span

IN THIS SECTION

Submittals

The Contractor provides PE stamped working drawings depicting the methods required to achieve the construction of the permanent structure. The Contractor also provides PE stamped shop detail drawings for any fabricated items designed by the EOR. The Contractor provides all submittals to the EOR for review and approval. The EOR responds to submittals by granting approval or requesting modifications within 5 working days. The project plans will indicate which submittals are necessary based on site-specific requirements. The following are examples of possible items to be included in submittals:

- Improvements to ground conditions at the BSA and along the TP, such as terrain leveling, grade adjustments, replacement of soft soils, etc.
- Evaluations of structures along the TP which are influenced by the move such as bridges or drainage structures to be crossed, retaining walls to be approached, etc.
- All temporary support structures including the temporary abutments and piers upon which the superstructure is cast, and the SPMT Supports. Additional temporary support structures include ramps, jacking towers, strand jacks, etc.
- The SPMT system including the configuration of SPMT units, the movement plan, contingency items, and emergency plans.

Contractor Synopsis

Lift and Transport

The Contractor provides all services related to construction and transport of the new span, and removal of the old span.

The span being replaced can be demolished in place or removed using SPMTs and taken to a demolition site.

Construct the temporary substructure. It is highly recommended that the support conditions of the temporary abutments are identical to the support conditions of the permanent abutments.

Construct the new span at a Bridge Staging Area (BSA) upon temporary abutments. It is advisable to under run the length of the span to ease placement.

Construct the permanent substructure. Ensure that final adjustments to the elevations of the abutments and bents are done prior to transporting the span. Shimming or grinding performed after transport has begun is permitted to ensure equal support to all girders and not to bring the span elevations to grade.

Transportation of the new span requires heavy lifting equipment and various site preparations to accommodate the lifting equipment. Only use SPMTs meeting the formal definition of an SPMT provided in this Manual. Other lifting and support structures may be required for the lift and transport of the span. They include jacking towers, used to elevate the span to its final setting height, ramps which the SPMTs may drive upon to bring the span to its final setting height, and the SPMT superworks. The SPMT superworks is the structure that sits atop the SPMTs and supports the span while it is being transported. The SPMT superworks is considered a bridge temporary works and subject to the same code requirements. Ensure that the temporary supports are positions in the exact location of the pick-points specified in the plans before the span is lifted off of its temporary abutments.

Prepare the BSA and Travel Path (TP) to accommodate the forces exerted by the SPMTs and to provide adequate clearance for the SPMTs and the span. Provide mitigation to redistribute loads if the SPMTs are to cross any soft soils or utilities. Ensure that terrain is even enough to keep minor adjustments within the stroke limits of the SPMTs.

Follow the planned geometric monitoring procedures during lift, transport, and setting. Provide measurements to the EOR to confirm that deflections are within allowable limits. Halt operations if deflections exceed allowed limits, returning the span to its temporary supports if necessary.

Design Involvement

In DBB projects the contractor bids on a completed design. Any changes the contractor wishes to make are to be submitted to the EOR for approval. The Contractor pays the cost of any re-designs necessitated by the Contractor's changes. The most common changes include:

1. Changing the pick-point location: This could be necessary if the SPMTs do not have adequate clearance from the side-walls or temporary abutments. The number of available axle lines differs from the number specified in the design. The Contractor there is a savings to altering the design.
2. Relocating the BSA: The Contractor may have access to or be aware of a BSA that requires less site preparation or is less expensive that the designed BSA.
3. Rerouting the TP: The Contractor may choose an alternate TP to accommodate a new BSA, or to avoid obstacles along the designed TP.

To enable value engineering to take place prior to bidding, and thus reduce the number and cost of change orders, the designers may invite contractors to an industry review prior to finalizing the plans.

SPMT projects require a number of specialized activities including verifying the design assumptions made by the EOR and providing designs of the Temporary Abutments, SPMT System, and SPMT supports. All shop drawings require a stamp by a professional engineer licensed to practice in the State of Utah. The Contractor may retain a Bridge Specialty Engineer (BSE) to carry out these activities. This Manual offers a section describing this role as a guide to the Contractor, but the Contractor is responsibly for satisfying these requirements. UDOT reserves the right to reject a BSE based upon experience or qualifications.

The Contractor is required to verifying the EOR's preliminary geotechnical assumptions with stamped drawings and calculations. The Contractor may retain a Geotechnical Engineer to carry out these activities. This Manual offers a section describing this role as a guide to the Contractor, but the Contractor is responsibly for satisfying these requirements. UDOT reserves the right to reject a Geotechnical Engineer based upon experience or qualifications.

The Contractor is responsible for providing lifting systems which meet the requirements of the project plans. Many SPMT movement systems are leased and operated by firms who have expertise in designing support systems and operating their equipment. The Contractor may retain a Heavy Lift Engineer to provide the SPMTs and operate them. This Manual offers a section describing this role as a guide to the Contractor, but the Contractor is responsibly for satisfying these requirements. UDOT reserves the right to reject a Heavy Lift Engineer based upon experience or qualifications.

Contractor Checklist page 1/2
Project Number _____ Date _____

#	Initial	Date	
1			Attend Industry Review
2			Attend Pre-bid Meeting
3			Select Heavy Lifter (HL)
4			Submit bid
5			Conduct Final Geotechnical Analysis of Bridge Staging Area (BSA) and Travel Path (TP)
6			Investigate proposed Temporary Abutment Design
7			Accept proposed Temporary Abutments or re-design Temporary Abutments
8			Investigate proposed Pick-Points
9			Accept designed-for Pick-Points or re-design Bridge
10			Design SPMT attachments and movement systems
11			Design TP, section, utility protection, pavement, clearance
12			Submit shop drawings, erection plans, and moving plans to EOR
13			Contractor re-designs bridge if proposal is not as designed
14			Build temporary abutments
15			Survey temporary abutments
16			Shim temporary abutments to final grade
17			Build Bridge on temporary abutments

18			Develop contingency plans
19			Build foundation
20			Survey abutments and bridge to determine required shims. Required before bridge is lifted off of temporary abutments
21			Develop safety plan
22			Final walk through. Total package reviewed before old bridge is taken out
23			Remove/demo old bridge
24			Move bridge
25			Coordinate with those monitoring move
26			Set span
27			Final assessment
28			Identify required repairs
29			Final site remediation

Contractor Checklist Description

1. **Attend industry review**
   The industry review invites contractors to make early recommendation on the construction means proposed by the designer. It also allows contractors to identify any alternative BSAs to which they may have leverage in gaining access.
2. **Attend pre-bid meeting**
3. **Select Heavy Lifter**
   Contractor selects the movement system and its operators. UDOT makes no distinction between Contractor and sub-contractors such as heavy-lifters, therefore the Contractor assumes full responsibility for the performance of the SPMTs. This includes any delays due to breakdown, and any damages to surfaces driven upon, above and below-ground utilities, the structure itself, the permanent substructure, etc.
4. **Submit bid**
5. **Conduct Supplemental Geotechnical Analysis of (BSA) and (TP)**
   Verify geotechnical assessments performed by the EOR with stamped drawings and calculations ensuring that the proposed BSA and TP are suitable for the Contractor's selected means of SPMT constructions. This includes confirming the stability of nearby slopes, anticipating settlement beneath the temporary and permanent foundations, and anticipating settlement beneath the SPTMs during lift, transport, and setting. It also includes verifying the means of mitigating ground stability, slope stability, and submerged utility issues. "Pavements and surface conditions are critical in areas where the SPMT are making sharp turns and the SPMT Firm shall be consulted concerning the use of steel plating or mats" (Nickus 20).
6. **Investigate Proposed Temporary Abutment Design**
   Analyze the different support conditions of the bridge and explore different scenarios concerning the chosen means and methods of fabrication, transportation, and erection. Confirm that the proposed temporary support types and locations best suit the contractor's chosen construction methods and conditions at the BSA.
7. **Accept proposed Temporary Abutments or re-design Temporary Abutments**
   The Contractor provides, and pays the cost of, a re-design when rejecting the designed-for Temporary Abutments.
8. **Investigate proposed Pick-Points**
   Confirm that the designed-for pick-points are compatible with the chosen SPMT system and with the layout of the BSA.
9. **Accept designed-for Pick-Points or re-design Bridge**
   The Contractor provides, and pays the cost of, a re-design when rejecting the designed-for pick points.
10. **Design SPMT attachments and movement systems**
    The supports upon the SPMT platform are, essentially, bridge temporary works. Conform their design to the AASHTO 1995 *Guide Design Specifications for Bridge Temporary Works*.
    There are addition safety factors that are required to account for the impact of lifting the bridge onto the SPTM supports, and the impact of transporting the

bridge. "Refer to Article 2.1.5.3 "Factor of Safety" for vertical shoring, jacks and all types of manufactured assemblies. Refer to Article 2.3.2 and Table 2.3 "Load Combinations (for what?) (Nickus 60)."

11. **Design TP, section, utility protection, pavement, clearance**
Provide stamped S&L for TP icluding details of mitigation for all ground stability, utility protection, above-ground clearance, etc.
Demark the travel path using paint, tape, barrels, etc.
12. **Submit shop drawings, erection plans, and moving plans to EOR**
Engineer reserves the right to review these drawings for up to 5 calendar days without granting an increase in the number of working days for the project. This right applies each time drawings are submitted.
13. **Contractor re-designs bridge if proposal is not as designed**
Contractor incurs costs due to faulty detailing or fabrications.
14. **Build temporary abutments**
15. **Survey temporary abutments**
16. **Shim temporary abutments**
Shim temporary abutments to designed-for elevations if necessary.
Verify that temporary abutments are at designed-for elevations.
17. **Build Bridge**
Construct bridge upon temporary abutments as if by conventional means. It is not required, but highly recommended that the support conditions for the Temporary Abutments are identical to the support conditions at the bridge site. "Provide at least the following details for the prefabrication of the permanent superstructure:

A. Dimensional, structural or similar physical changes to the superstructure itself and calculations for the verification of stress levels within or the strength capacity of the superstructure necessitated by:
   i. Contractor's elected SPMT construction method.
   ii. Changes of locations of temporary and/or permanent support conditions.
   iii. Changes to cross-section component sizes and/or connectivity (shear studs or shear reinforcement).
   iv. Relocation of construction joints (in any plane).
   v. Sequence and installation of prestressing forces (by pre- or post-tensioning).
   vi. Distortion (twist) or differences in deflection or camber from unintentional support settlement or differences in anticipated elevations.
   vii. Unexpected changes of conditions during lifting, transportation and setting of the superstructure and the like.

B. Details for forms for the deck and any diaphragms or similar members to be cast along with the superstructure.

C. Where minor alterations are made to the superstructure geometry shown in the Contract Plans, indicate the size, spacing and location, of any special reinforcement required but not shown on the Contract Plans, with a clear and concise cross-reference to the appropriate Contract Plans to which the variations apply. Variations to these dimensioning will change the gross weight, as will the concrete mix.

D. Details of anticipated camber of prefabricated girders (steel or concrete) prior

to and after casting a deck slab, along with any appropriate adjustments in the setting of deck forms, as necessary.

E. For concrete pours, show locations of proposed construction joints (in any location and plane) and proposed concrete pouring sequence.

F. For monolithic cross-sections, such as box girders or voided slabs, show proposed sequence of discharge of to avoid the formation of cold joints. Also, show locations of proposed horizontal construction joints in webs, diaphragms and the like.

G. For deck slabs, show on shop drawings, location and proposed means of avoiding the formation of cold joints.

H. Weights and quantities of pay items."

(Nickus 68-69)

I. Install the designed-for devices or reference points (such as bolts) to be used to monitor the dimensions of the structure during lift, transport, and setting.

18. Develop contingency plans

Provide failsafe methods to minimize delays if the SPMT should have a breakdown. Include a list of spare parts kept on hand and acceptable limits for partial equipment failure (such as loss of mobility to a specified number of wheels, etc.). For parts not kept on hand include a list of where these parts can be obtained and estimates of how long it would take to replace them. Include plans to secure the structure during the delay so that traffic may safely resume if necessary.

Provide contingency plans for fit issues (such as the possible need to grind approach slabs to fit the new superstructure, emergency shimming, etc.).

Provide contingency plans for failure of all or part of the SPMT support system (such as hydraulics jacks, support beams, etc.)

Provide contingency plans for unexpected settlement beneath SPMTs.

Provide contingency plans for emergency stopping over utilities, including binding permission from the utility owners.

19. Build foundation

20. Survey abutments and bridge to determine required shims. Required before bridge is lifted off of temporary abutments.

Provide details of adjustments to the elevations or positions of abutment and pier bearings as necessary to accommodate the prefabricated superstructure. The shims may be placed on the top of the abutments or on the bottom of the girders, so long as these attachments do not impede future maintenance of the bearing pads. Contractor is responsible for any delays due to grade adjustments performed after the bridge is lifted from the temporary abutments.

21. Develop safety plan

Provide plans to ensure safety of public, spectators, and workers including established perimeters, set schedule of operations, organization of machinery, requirements for safety gear, etc.

22. Final walk through. Total package reviewed before old bridge is taken out.

Conduct final walk-through with Contractor, EOR, Safety Supervisor, SPMT operator/supervisor (if other than contractor), UDOT State Bridge Engineer, and the designer of the temporary supports and SPMT supports (if other than Contractor).

23. Remove/demo old bridge

Dispose of old bridge by the means specified in the contract. Demolish old bridge on site, or remove old bridge using SPMTs and take it to demolition site. If the bridge is being removed the Contractor may waive all serviceability requirements.

24. Move Bridge

Lift, Transport, and Setting Plan

A. Confirm that the ground and TP are clear of damage or unexpected defects since being prepared.
B. Check actual overall height and width of SPMT System prior to insertion and confirm that the clear height and width available is sufficient to receive the SPMT System.
C. Conduct diagnostic of SPMT System.
D. Immediately prior to lifting, record elevations at designated locations at each end of span, mid-span and lift points on each of the two edge beams and confirm that twist detection lines are set.
E. Engage SPMT lifting system and slowly take load of superstructure span.
F. Ensure that there is even lift-off at all bearings
G. Check engaged weight against anticipated weight given on Shop Drawings (*can this be done?*)
H. Compare the actual performance of the span as it is lifted from its temporary shoring to the required jack stroke estimates, the maximum anticipated deflection, and the maximum allowable deflection.
I. Follow the procedures specified in the lift plan if the span does not perform as expected, or if it approaches critical tolerances.
J. Follow the procedures specified in the contingency plan to address issues (if any) with the structure, supports, lift system, or ground.
K. When span has been successfully lifted and all monitoring devices are within tolerance limits, proceed with transportation begin move to Bridge Site.
L. If during transport, twist distortion appears likely to exceed allowable limit, immediately stop and refer to contingency plan.

(Nickus 72)

25. Coordinate with those monitoring the move

Real-time communication is possible via two-way radio, hand signal, cell phone, text message, etc.

Identify the following primary points of contact:

SPMT Supervisor Name:_____Contact info:_____
GC Supervisor Name: _____Contact info:_____
Safety Supervisor Name:_____Contact info:_____
EOR Name:_____ Contact info:_____
UDOT CM name:_____ Contact info:_____

26. Set span

A. Before setting the span, check clearances at installation site - vertically, horizontally and skew-wise - to ensure span can properly enter intended permanent in-place location.

B. Check that all bearings are at planned elevations and match the underside elevations, slope and profile of the already completed span. All shimming is to have taken place prior to removing the span from its temporary supports. Any shim installation not specified in the design and taking place immediately prior to setting the span can result in disincentives and/or delay-related penalties.
C. Bring span into close proximity in elevation and location.
D. Prior to final setting down, take a set of elevation observations on deck "before setting."
E. Set span down on bearings.
F. Notify UDOT of any errors or out of tolerance situation. Propose and seek approval for rectification - or rectify in accordance with previously approved concepts involving shim plates. This may involve the re-lifting and resetting of the span.
G. Take final set of elevation observations after setting span in permanent place to verify that tolerances are within anticipated and allowable limits shown in the specifications for permanent elevations.

(Nickus 72)

27. Final assessment

Remove all temporary bridge attachments.
Visually inspect the deck, abutment backwalls, and abutments/piers.
Provide measurements confirming that bridge is resting within tolerable limits of the designed-for position (for X, Y, and Z axis).

28. Identify required repairs and perform approved repairs

Identify major spalling and cracking.
Identify minor spalling and cracking.
Repair all according to UDOT Spec.

29. Final site remediation

Restore conditions at BSA, TP, Installation Site, Demolition site.
Restore normal traffic service.

Contractor's

Bridge Specialty Engineer

In This Section

Overview

The Contractor provides all services related to:

- Design of the temporary substructure
- Design and load assumption verification
- Design of SPMT supports
- Damage inspection

The Contractor may chose to employ a Bridge Specialty Engineer to perform some or all of these services.

Design Responsibilities:
Contractor provides design of temporary supports meeting AASHTO LRFD Design Guide for Bridge Temporary Works.

It is highly recommended that the temporary supports be designed to mimic permanent abutments.

Contractor provides designs for SPMT supports.

Contractor provides designs for permanent work not specified in the plans and required to be furnished by the contractor.

Contractor re-designs bridge if not using the EOR-designed pick-points.

Verification Responsibilities:
Once construction has begun, the Contractor is responsible for the integrity of the structure until it is delivered to its permanent position and accepted by the UDOT. Contractor verifies the strength capacity of the superstructure as a result of using SPMTs.

Damage Inspection:
In the event of cracking or damage, the Contractor's BSE is to be responsible for inspection of the superstructure, the development of repair proposals and verification of the repaired structures.

Qualifications:
The BSE will be a PE licensed to practice engineering in the State of Utah.

Bridge Specialty Engineer Synopsis

The EOR designs the bridge superstructure based on a number of assumption which the Contractor is responsible for confirming and using. These assumptions include:

- Structural dimensions (size/weight)
- Structural tolerances
- Pick-point locations
- Configuration of SPMT system
- Geotechnical findings at the proposed BSA and along the proposed TP

The basic dimensions of the structure influence all other design assumptions. The Contractor provides the as-caste profile of the superstructure, including dimensions and weight, and the EOR confirms that the as-caste information is within range of the assumptions.

The load limits are established based upon the profile of the structure and the assumed properties of construction material. The EOR designs the superstructure for various load factors while it is under construction, transport, and in permanent position. The Contractor verifies that no load factors are exceeded. The assumed tolerances of the structure influence the pick-points because the locations of temporary supports are chosen so as not to place strain on the structure while under temporary support conditions.

The Contractor verifies the EOR's anticipated deflections for the designed pick-points. The Contractor verifies that the chosen SPMT system can be configured to match the design for the number of axle lines, load distribution, and pick-points. If the chosen SPMT movement system cannot be configured to match the design the Contractor verifies that the actual configuration will work with all related project plans. The assumed configuration of the SPMT systems affects wheel load estimates, which in turn influence the design of the BSA and TP.

The Contractor carries out all ground preparations and soil mitigations per the EOR designs for the BSA, TP, and final bridge location.

The Contractor verifies all assumptions with calculations and shop drawings stamped by a Professional Engineer (PE) licensed in the State of Utah. A change to any of these assumptions may affect all other assumptions and possibly require a redesign of the project. For instance, a change to the BSA/TP may require a change to mitigation or a change to the configuration of the SPMT system. A change to the Configuration of the SPMT system may require a change to the location of the pick-points, and a change to the location of the pick points may require a change to the design of the structure. The Contractor incurs the cost of any redesigns made necessary by the Contractor's chosen methods.

In addition to verifying EOR assumptions and providing redesigns when needed, the Contractor has certain design responsibilities. The Contractor is responsible for the design of all temporary structures including the temporary abutments at the BSA and the SPMT support structures. The Contractor may also design other temporary or permanent structures not specified or deemed non-essential by UDOT. Provide all designs stamped by a PE licensed in the State of Utah.

BSE Checklist
Project Number Date

#	Initial	Date	
1			Design temporary abutments and SPMT supports.
2			Obtain EOR approval of the lift point locations and means of connections, if any, to the bridge.
3			EOR verified that the design plans provided by the SPMT contractor are the latest and correct version.
4			Contractor has provided EOR with temporary shoring plans and EOR has stamped temporary shoring plans as a shop drawing indicating NO EXCEPTIONS to any temporary supports and shoring.
5			Contractor, EOR, HL, and BSE have had a meeting to discuss the physical attachment of the bridge to the SPMT.
6			A communication plan has been clearly defined to keep all key players up to date on the bridge move.
7			A pre-move technical meeting has been held to discuss any pertinent technical issues that may arise during the bridge move.
8			Temporary bridge attachments, such as rigging, have been installed per plan. Rigging has been verified by designated supervisor.
9			SPMT rigging and safety plan is in place.
10			Instrumentation/equipment to perform required bridge measurements in place.

BSE Checklist Description

1. Design temporary bents or abutment type seats to support span under construction Include piling, spread footings or other foundation, and all geotechnical investigation and calculations for the foundation of temporary abutments. Conform the design to AASHTO 1995 *Guide Design Specifications for Bridge Temporary Works*.
2. Contractor submits stamped design of SPMT supports including their particular location and means of attachment to the structure to EOR for approval.
3. Ensure that construction of SPMT movement system and all related apparatus is conducted per the current plan set.
4. Contractor provides stamped designs for all temporary abutments to be used during construction. Follow AASHTO LRFD Design Guide for Bridge Temporary Works. It is recommended practice to cast the span in the same orientation as the in-service condition.
5. All parties are in agreement that the attachments are adequate for the anticipated forces that the bridge may be subject to and will also accommodate and anticipated bridge rotation and translation during the move.
6. Contractor provides itinerary for date of move and establishes contact between key players.
7. Engage the EOR and any other specialized engineers (geotech engineer, heavy lift engineer, bridge specialty engineers) to ensure that all means and methods are sufficient to account for all forces without causing any harm to people, above and below-ground property, or the bridge itself.
8. Contractor verifies that rigging is attached per plan.
9. Rigging has been verified by designated supervisor (safety manager, lift superintendent, etc.) Plan is in place to monitor rigging chains during the transport and placement of the bridge.
10. Contractor confirms that all monitoring devices and or reference points are properly installed in their designed-for locations and are providing data.

Contractor's

Heavy Lift Engineer

In This Section

Overview
The Contractor provides all services related to the procurement, maintenance, and operation of SPMTs. The Contractor may employ a Heavy Lifter (HL) to perform some or all of these services. Although UDOT may approve the Contractor's chosen HL, UDOT's only relationship is with the Contractor.

Submittals:

Moving bridges using SPMTs is a sensitive process that requires strict adherence to performance criteria. Provide documentation to the Resident Engineer (RE) assuring that the equipment used in the selected SPMT movement system is adequate. Items to consider include:

- Axle load
- Stroke capacity
- 360 degree Axle articulation
- Synchronization of combined units
- Maneuvering precision
- Turning capacity
- Ability to climb grade along TP

During a bridge move any unexpected delays increase the service interruption to the traveling public and jeopardize the structure. Provide documentation to the RE that there is a process in place to minimize the likelihood of equipment failure during the move. This may include maintenance checklists and contingency plans for any equipment failures by any part of the entire movement system.

Design:
The project design is based upon an assumed movement system. The SPMT movement system influences aspects of the project design including the Bridge Staging Area (BSA), Travel Path (TP), temporary support structures, and the bridge itself. If the Contractor's elected movement system differs from the design assumptions, modifications to the overall design may be required.

Transportation:
SPMTs may be employed to remove the existing superstructure and transport it to the demolition site (unless demolition is conducted at the bridge site). The HL lifts the new superstructure from temporary supports and onto SPMT supports, providing equal support to all girders. The HL transports the new superstructure from the BSA into position, then lowers the superstructure onto the abutments with all four corners settling simultaneously.

HL Synopsis

The contractor is responsible for all activities related to lifting the bridge from its temporary abutments, transporting it to the final bridge site, and placing the bridge upon its permanent abutments. This includes the SPMT system, jacking towers, ramps, etc.

The EOR will design the Bridge Staging Area (BSA), Travel Path (TP), and superstructure assuming a specific number of axle lines and a specific configuration of the SPMT system. The contractor may elect not to use the assumed equipment configuration due to the availability of equipment, value engineering, or constrictions at the BSA, TP, or final bridge site which make the designed configuration of SPMTs unsuitable. These changes can necessitate changes to the BSA and TP, or changes to the superstructure design if the pick-points are relocated. Any changes to the design are stamped by a professional engineer and submitted to the EOR for review.
Stamped drawings are required for the SPMT superstructure (the supports located on top of the SPMTs which support the bridge during transport operations).

The Contractor's elected method of SPMT construction will determine how equal support is provided to all girders at designated pick-points. Some methods are well established within the industry. The Heavy Lift firm can provide expertise on the construction of the SPMT support apparatus, but a professional engineer licensed in the State of Utah must stamp the SPMT support drawings.

HL Checklist
Project Number Date

#		Initial	Date	Pre-Move
1				SPMT plans for lifting and transporting bridge are complete. Plans include the following:
	A			SPMT plans indicate total bridge weight.
	B			SPMT plans indicate that all equipment is adequate to support loads and transport freight along TP
	C			SPMT plans reference design plan used for development.
	D			SPMT plans include a maintenance checklist
	E			SPMT plans indicate maximum top of SPMT tilt in X and Z direction anticipated during move.
	F			SPMT plans indicate maximum ground bearing pressure.
	G			SPMT plans show trailer position with respect to the bridge in X and Z directions.
	H			SPMT plans indicate which elements are to be provided or designed by GC.
	I			SPMT plans indicate where additional support or equipment is required.
	J			SPMT plans indicate falsework removal plan.
	K			SPMT plans will not allow for any additions to the structure that may be detrimental to it.
	L			SPMT plans indicate TP if differing from designed TP
	M			All plans are stamped by an engineer licensed in the State of Utah
2				EOR and Contractor have had a meeting to discuss the physical attachment of the bridge to the SPMT and are in agreement that the attachments are adequate for the anticipated forces that the bridge may be subject to and will also accommodate and anticipated bridge rotation and translation during the move.
3				Contractor has verified that the actual existing profiles and cross slope conditions at proposed wheel lines are within the planned wheel strokes of the SPMT.
4				Contractor, EOR, UDOT/RE have performed a walk through of the anticipated travel path.
5				Contractor has verified that the actual clearance to existing terrain features (side slopes, light poles, signs, barriers) are adequate to permit passage of any bridge overhangs, additional protrusions required to carry the load, SPMT power units, required personnel.
6				Contractor has confirmed that adequate room is available between the bridge being carried and any terrain features to permit passage of a vehicle or confirm that another path is available for vehicles and equipment to move from one side of the bridge to the other.
7				If chains or other means of physical attachment are required between the SPMT and bridge during transport, notes on the SPMT plans indicate when the chains or connection must be tightened, for example, “tighten chains after the bridge is lifted.” Likewise plans indicate when the connection could be loosened. For example, “Loosen chains just prior to setting down on the bearings.”

8			Geotechnical estimates of soil deflections have been reviewed.
9			A communication plan has been clearly defined to keep all key players up to date on the bridge move.
10			A pre-move technical meeting has been held to discuss any pertinent technical issues that may arise during the bridge move.
			During Move
11			Area under SPMTs at lift location is stable.
12			Combined safety meeting between Contractor, and UDOT RE held within 8 hours of bridge lift.
13			Load and support positions have been clearly marked on the bridge and load carrying equipment.
14			Plan is in place for final safety checks during the bridge transport and placement. Check the attachments between the bride and the SPMT supports. Verify slide path is clear of foreign objects.
15			Lift, transport, and setting

HL Checklist Description

1. Refer to sample plans
2. Determine the actual locations of the pick-points. The EOR provides designed-for pick points. It may not be possible to integrate the designed-for pick points with the BSA and the chosen SPMT movement system.
3. Inconsistencies between the planned and actual profiles of the terrain along the wheel lines of the SPMTs can affect the performance of the SPMT movement system.

4. Confirm that the travel path is marked on the ground and free of obstructions. Confirm that all above-ground obstacles have been mitigated per plans. Confirm that the exact wheel lines of the SPMTs are marked.
5. Such verification is provided to the RE during the walk-through and is supported by measurements showing the anticipated clearance between all obstacles along the TP.
6. Verify that the SPMT movement system will not obstruct the movements support personnel and vehicles around the construction site.
7. Self-explanitory
8. Confirm geotechnical estimates will not cause damage. Anticipated settlements are accounted for in the movement system.
9. Real-time communication is possible via two-way radio, hand signal, cell phone, text message, etc.
   The following primary points of contact must be identified:
   SPMT Supervisor Name:_____Contact info:_____
   GC Supervisor Name: _____Contact info:_____
   Safety Supervisor Name:_____Contact info:_____
   EOR Name:_____ Contact info:_____
   UDOT RE name:_____ Contact info:_____
   UDOT Deputy Bridge Engineer:_____Contact info:_____
10. Engage the EOR and any other specialized engineers (geotech engineer, heavy lift engineer, bridge specialty engineers) to ensure that all means and methods are sufficient to account for all forces without causing any harm to people, above and below-ground property, or the bridge itself.
11. Provide ground stability mitigation based upon the anticipated load and the capabilities of the machinery.
12. Review safety plan with all personnel involved in the bridge move. This includes both contractor personnel and UDOT personnel. Safety standards for constant factors such as equipment and structures should already be in the plans. Conduct the safety meeting within hours of the move to ensure that variable factors, such as weather conditions, are be incorporated into the safety plan.
13. Verify that the marks of load and support positions on the bridge and carrying equipment are clearly marked and in the accurate locations.
14. Inspect connections between lift and support points, ensuring the integrity of all welds, etc.

15. Lift, Transport, and Setting Plan

a. Confirm that the ground and TP are clear of damage or unexpected defects since being prepared.
b. Check actual overall height and width of SPMT System prior to insertion and confirm that the clear height and width available is sufficient to receive the SPMT System.
c. Conduct diagnostic of SPMT System.
d. Immediately prior to lifting, record elevations at designated locations at each end of span, mid-span and lift points on each of the two edge beams.
e. Engage SPMT lifting system and slowly take load of superstructure span.
f. Ensure that there is even lift-off at all bearings
g. Check engaged weight against anticipated weight given on Shop Drawings.
h. Compare the actual performance of the span as it is lifted from its temporary shoring to the required jack stroke estimates, the maximum anticipated deflection, and the maximum allowable deflection.
i. Follow the procedures specified in the lift plan if the span does not perform as expected, or if it approaches critical tolerances.
j. Follow the procedures specified in the contingency plan to address issues (if any) with the structure, supports, lift system, or ground.
k. When span has been successfully lifted and all monitoring devices are within tolerance limits, proceed with transportation begin move to Bridge Site.
l. If during transport, twist distortion appears likely to exceed allowable limit, immediately stop and refer to contingency plan.
m. Before setting the span, check clearances at installation site - vertically, horizontally and skew-wise - to ensure span can properly enter intended permanent in-place location.
n. Check that all bearings are at planned elevations and match the underside elevations, slope and profile of the already completed span. All shimming is to have taken place prior to removing the span from its temporary supports.
o. Bring span into close proximity in elevation and location.
p. Prior to final setting down, take a set of elevation observations on deck “before setting.” Any shim installation or grinding required to provide even support to all girders should be executed now. Shimming to set the bridge to final elevation is prohibited.
q. Set span down on bearings.
r. Notify UDOT of any errors or out of tolerance situation. Propose and seek approval for rectification - or rectify in accordance with previously approved concepts involving shim plates. This may involve the re-lifting and resetting of the span.
s. Take final set of elevation observations after setting span in permanent place to verify that tolerances are within anticipated and allowable limits shown in the specifications for permanent elevations.

Resident Engineer (RE)

In This Section

Overview

The RE is a UDOT employee or hired consultant who represents UDOT by providing oversight throughout design and construction. Oversight consists mainly of ensuring conformity to plans and specifications.

Key oversight functions during construction include:

- Holding pre-bid meeting
- Holding pre-construction meeting
- Confirming review and approval of submittals
- Coordinating with PIM
- Ensuring construction in compliance with approved plans and specs
- Coordinating deviations from plans with appropriate parties
- Conducting final inspection
- Holding lessons learned meeting

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Key oversight functions during design include:

- Conduct plans review
- Conduct standards review
- Conduct specifications review
- Conduct constructability review
- Review construction schedule

The RE may employ a staff of inspectors to carry out various aspects of the oversight process, or UDOT may assign various consultants to report on aspects of the oversight process.

Synopsis

During the design phase the RE represents UDOT by upholding standards and communication protocol. The checklists contained in this manual represent UDOT standards for moving bridges using SPMT. They are written to key members involved in projects using SPMTs to move bridges. The checklists are intended to clearly assign liability and describe required tasks. Each project will require customized checklists which may not require specific action on every checkpoint included in this manual. The RE verifies that the project plans address all applicable standards and specifications. The RE also reviews the project plans to ensure constructability, and to ensure that the construction schedule is satisfactory. When the plan documents are complete the RE recommends approval of the plans for advertising.

The construction phase of oversight begins prior to awarding the contract. The RE attends a pre-bid meeting in which contractors must attend in order to be allowed to bid on a project. The purpose of the pre-bid meeting is to explain UDOT's intent on a project and to emphasize certain aspects of the project which should be considered in the bid.

Following the notice of award there is to be a pre-construction meeting. At this meeting the Contractor provides a first draft of shop drawings. The purpose of the pre-construction meeting is to discuss the Contractor's selected SPMT movement system, BSA and TP movements, subcontractors, deviations from project plans, schedule, MOT, and utilities. The RE ensures that the Contractor submits any deviations from the project plans to the appropriate parties, such as structures design, EOR, traffic, utilities, etc. The RE confirms that submittals are reviewed and approved before affected work begins or continues.

Throughout construction the RE coordinates with the PIM, field checks to ensure that work is performed in compliance with the project plans, and that submittals are flowing through the proper channels.

At final inspection the RE ensures that the Contractor, the EOR, and a representative of UDOT Structures Division are present.

RE Master Checklist
Project Number Date

#	Responsibility	Action
1	**EOR**	Identify and investigate final bridge location, possible bridge staging area (BSA), and Travel Path (TP). (DB Provision to be added later)
2	**EOR**	Select bridge type and transport configurations.
3	**EOR**	Design BSA and TP
A	**EOR**	Identify modifications along TP
B	**EOR**	Written sign-off on utilities
C	**EOR**	Investigate clearance
D	**EOR**	Perform load rating of bridges along proposed TP
4	**EOR**	Draft Situation and Layout (S&L) for final bridge location
A	**EOR**	Clearance
B	**EOR**	Geotech, utilities, etc.
C	**EOR**	Identify components built in place
D	**EOR**	Identify components built elsewhere and moved into place
E	**EOR**	Identify pick-points
1	**EOR**	Compile list of HLs
2	**EOR**	Consult Heavy Lifters (HLs) to design bridge with pick-points
5	**EOR**	Review total plan package
6	**EOR, Contractor**	Industry review

7		**EOR**	Final design
	A	**EOR**	S&L of permanent structures
	B	**EOR**	S&L of BSA and TP
	C	**EOR**	S&L for removal or demolition of structure to be replaced
8		**EOR**	Attend plan review meeting with UDOT and entire design team
9		**EOR**	Finalize Plan
	A	**EOR**	Develop criteria for temporary supports
	B	**EOR**	Develop criteria for deflection, twist, etc.
	C	**EOR**	Write specs
	D	**EOR**	Stamp designs
10		**EOR**	Develop monitoring plan
11		**EOR**	Develop cost estimates for temporary abutments
12		**Contractor, EOR**	Attend Pre-bid Meeting
13		**Contractor**	Select Heavy Lifter (HL)
14		**Contractor**	Submit bid
15		**Contractor**	Conduct Final Geotechnical Analysis of Bridge Staging Area (BSA) and Travel Path (TP)
16		**Contractor**	Investigate proposed Temporary Abutment Design
17		**Contractor**	Accept proposed Temporary Abutments or re-design Temporary Abutments
18		**Contractor**	Investigate proposed Pick-Points

19	**Contractor**	Accept designed-for Pick-Points or re-design Bridge
20	**Contractor**	Design SPMT attachments and movement systems
21	**Contractor**	Design TP, section, utility protection, pavement, clearance
22	**Contractor**	Submit shop drawings, erection plans, and moving plans to EOR
23	**EOR**	Review shop drawings
24	**Contractor**	Contractor re-designs bridge if proposal is not as designed
25	**EOR**	Provide construction support
26	**Contractor**	Build temporary abutments
27	**Contractor**	Survey temporary abutments
28	**Contractor**	Shim temporary abutments to final grade
29	**Contractor**	Build Bridge on temporary abutments
30	**Contractor**	Develop contingency plans
31	**Contractor**	Build foundation
32	**Contractor**	Survey abutments and bridge to determine required shims. Required before bridge is lifted off of temporary abutments
33	**Contractor**	Develop safety plan
34	**Contractor, EOR**	Final walk through. Total package reviewed before old bridge is taken out
35	**Contractor**	Remove/demo old bridge
36	**Contractor**	Move bridge
37	**Contractor**	SPMT plans for lifting and transporting bridge are complete. Plans include the following:

	A	**Contractor**	SPMT plans indicate total bridge weight.
	B	**Contractor**	SPMT plans indicate that all equipment is adequate to support loads and transport freight along TP
	C	**Contractor**	SPMT plans reference design plan used for development.
	D	**Contractor**	SPMT plans include a maintenance checklist
	E	**Contractor**	SPMT plans indicate maximum top of SPMT tilt in X and Z direction anticipated during move.
	F	**Contractor**	SPMT plans indicate maximum ground bearing pressure.
	G	**Contractor**	SPMT plans show trailer position with respect to the bridge in X and Z directions.
	H	**Contractor**	SPMT plans indicate which elements are to be provided or designed by GC.
	I	**Contractor**	SPMT plans indicate where additional support or equipment is required.
	J	**Contractor**	SPMT plans indicate falsework removal plan.
	K	**Contractor**	SPMT plans will not allow for any additions to the structure that may be detrimental to it.
	L	**Contractor**	SPMT plans indicate TP if differing from designed TP
	M	**Contractor**	All plans are stamped by an engineer licensed in the State of Utah
38		**Contractor**	EOR and Contractor have had a meeting to discuss the physical attachment of the bridge to the SPMT and are in agreement that the attachments are adequate for the anticipated forces that the bridge may be subject to and will also accommodate and anticipated bridge rotation and translation during the move.
39		**Contractor**	Contractor has verified that the actual existing profiles and cross slope conditions at proposed wheel lines are within the planned wheel strokes of the SPMT.
40		**Contractor**	Contractor, EOR, UDOT/RE have performed a walk through of the anticipated travel path.
41		**Contractor**	Contractor has verified that the actual clearance to existing terrain features (side slopes, light poles, signs, barriers) are adequate to permit passage of any bridge overhangs, additional protrusions required to carry the load, SPMT power units, required personnel.
42		**Contractor**	Contractor has confirmed that adequate room is available between the bridge being carried and any terrain features to permit passage of a vehicle or confirm that another path is available for vehicles and equipment to move from one side of the bridge to the other.

43	**Contractor**	If chains or other means of physical attachment are required between the SPMT and bridge during transport, notes on the SPMT plans indicate when the chains or connection must be tightened, for example, "tighten chains after the bridge is lifted." Likewise plans indicate when the connection could be loosened. For example, "Loosen chains just prior to setting down on the bearings."
44	**Contractor**	Geotechnical estimates of soil deflections have been reviewed.
45	**Contractor**	A communication plan has been clearly defined to keep all key players up to date on the bridge move.
46	**Contractor**	A pre-move technical meeting has been held to discuss any pertinent technical issues that may arise during the bridge move.
47	**Contractor**	Area under SPMTs at lift location is stable.
48	**Contractor**	Combined safety meeting between Contractor, and UDOT RE held within 8 hours of bridge lift.
49	**Contractor**	Load and support positions have been clearly marked on the bridge and load carrying equipment.
50	**Contractor**	Plan is in place for final safety checks during the bridge transport and placement. Check the attachments between the bride and the SPMT supports. Verify slide path is clear of foreign objects.
51	**Contractor**	Coordinate with those monitoring move
52	**Contractor**	Set span
53	**EOR, Contractor**	Final assessment
54	**Contractor**	Identify required repairs
55	**Contractor**	Final site remediation